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(54) **HEAT EXCHANGE TUBES**
WÄRMTETAUSCHERROHRE
TUBES ECHANGEURS DE CHALEUR

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Des ription

This invention relates to a heat exchanger tube comprising the features as indicated in the precharacterising part of claim 1 and to a method of forming a heat exchange tube. A heat exchange tube of this kind is known, for example, in EP-A-0 302 232, in which the corrugated insert is formed integrally with the outer wall of the tube by means of deformation of a sheet or strip of metal. The heat exchange tube disclosed in European patent specification 0302232 is however difficult to produce in practice particularly where automated production is required. Such heat exchanger tubes are used for heat exchangers such as vehicle radiators, condens- rs, oil coolers, intercoolers and heaters or the like.

Heat exchange tubes are arranged to carry therein a first fluid medium whilst a second fluid medium is in contact with the exterior of the tube. Where a temperature difference exists between the first and second fluid media heat will be transferred between the two via the heat conductive walls of the tube.

It is known to provide corrugated fins or ribs in the interior of heat exchanger tubes to increase the surface area of conductive material available for heat transfer, and/or cause turbulence of the fluid carried in the interior of the tube. In both cases, heat transfer efficiency is increased. In one known construction a roll formed clad aluminium tube is provided with an insert in the form of a sheet of corrugated fins; insertion of the sheet of corrugated fin into the tube is extremely difficult and typically achievable only manually due to required tight dimensional tolerances between the tube and corrugated fin sheet insert. In another known construction, heat exchange tubes are formed by extrusion from aluminium billets. In this construction internal ribs are formed during xtrusion, however extruded tubes are formed from aluminium billet and not clad aluminium, which causes problems when attempting to braze the assembled heat exchanger. Furthermore, extruded heat exchange tubes are expensive to produce.

An improved heat exchange tube has now been devised which alleviates some of the above-mentioned difficulties.

In accordance with a first aspect of the invention, there is provided a heat exchange tube comprising the features according to claim 1.

The common longitudinal seam line comprises a line of abutment of respective portions of the wall of the tube which are inverted during forming to position the groups of fins internally of the tube.

Typically the common longitudinal seam line comprises a bonded join, typically a brazed join.

It is pref rred that a pair of groups of fins are provided, advantageously extending transversely from the seam line to substantially the same extent such that in transverse cross-section the tube is preferably substantially symmetrical about the seam line.

Desirably, the shaped portions of the strip or sheet material defining each group of fins are preferably separated from one another by interconnecting portions, which interconnecting portions are not provided with fins.

Advantageously, th groups of fins are provided each adjacent a respective longitudinally running peripheral edge of the sheet or strip material.

The tube is required to be heat conductive, and therefore the strip or sheet material from which the tube is formed is typically of metal or alloy. It is preferred that the strip or sheet material comprises clad aluminium to aid in the brazing of the tube and also the brazing of the final heat exchanger assembly. Portions of the fins are typically brazed to respective portions of the outer wall to improve the thermal conductive connection therebetween.

In use, the heat exchange tubes are arranged for flow of heat transfer fluid therethrough from an inlet to an outlet spaced therefrom along a fluid flow path between the inlet and outlet defined by the tube.

Advantageously, the outer surface profile of the tube is arranged such that effectively two substantially parallel external heat exchange surfaces are provided. It is preferred that the width of the heat exchanger tube is substantially greater than its thickness.

The corrugated fins may comprise castellations or any other suitable configuration having fin surfaces extending between opposed portions of the outer wall of the tube. In a preferred embodiment the corrugated fins are provided with louvres or slits such that fluid may pass through the surfaces of the corrugated fins. Typically, the corrugated fins define a plurality of longitudinally extending fluid flow pathways along the interior of the tube.

Typically, the heat exchange tube is formed by a roll forming process, and therefore, according to a second aspect, the invention comprises a method of forming a heat exchange tube comprising forming respective series of fins in respective deformable portions of strip or sheet material, and subsequently deforming further portions of the strip or sheet material to provide an outer wall surrounding the groups of fins, whereby the series of fins extend from a common longitudinal seam line in mutually opposed directions which directions are transverse to the longitudinal direction of the seam line.

Desirably, two respective groups of fins are provided, each in the region of a respective longitudinally running edge of the strip or sheet material.

Advantageously, subsequently to formation of the groups of fins, the sheet material is deformed symmetrically about a longitudinal axis to form the heat exchange tube.

It is preferred that the portions of the sheet material provided with respective groups of fins are folded (typically by roll forming) toward one another causing intermediate portions of the sheet or strip material to wrap around the groups of fins thereby providing the outer wall.

Typically, th tube is then brazed along the seam line to form a joining interface between the respective groups of fins.

The inv ntion will now be furth r described in a specific embodiment by way of example only and with reference to the accompanying drawings, in which:

Figures 1 to 3 show known heat exchange tubes of various constructions;
Figure 4 shows an initial stage in the formation of a heat exchanger tube according to the invention;
Figures 5 and 6 show successive intermediate stages in the formation of a heat exchanger tube according to the invention;
Figure 7 shows a section of finished heat exchanger tube according to the invention:
Figure 8 shows a preferred embodiment of a part of the heat exchanger tube shown in Figure 7; and
Figure 9 is a schematic representation of apparatus arranged to form the finished heat exchanger tube shown in Figure 7.

Referring initially to Figures 1 to 3, various types of known (prior art) heat exchanger tubes are shown. Figure 1 shows a tube 13 which comprises an outer wall 14 roll formed from clad aluminium strip which is then brazed along a longitudinal edge. A fin corrugated insert 15 is subsequently inserted into the tube and brazed to give a good thermal connection to the outer wall 14.

Referring to Figure 2, there is shown an extruded heat exchange tube 16 which is extruded integrally from aluminium billet stock. Fins 17 are formed integrally with the outer wall 18 during extrusion. Referring to Figure 3, there is shown a typical oil cooler heat exchange tube 19 extruded from billet stock.

Referring now to Figures 4 to 9 which relate to the present invention, there is shown a section of elongate heat exchanger tube generally designated 1. The tube shown is suitable for use in heat exchangers such as vehicle radiators, condensers, oil coolers, intercoolers, heaters etc. where heat is to be transferred between a first fluid medium carried in the interior of tube 1 (usually at a relatively high temperature for radiators and oil coolers) and a second fluid medium which passes over the exterior surfaces of the tube (usualy at a relatively lower temperature for radiators and oil coolers).

The tube 1 is formed integrally from a single initially flat strip of clad aluminium by a roll forming process (described below) such that integral corrugated fins 2 are formed in the interior of the tube 1. The tube is then brazed (typically in unison with the remainder of the assembled heat exchanger) using a known brazing process to give a single longitudinal brazed tube join along longitudinal seam 3 and give good brazed thermally conductive connection between the crests and troughs of the corrugated fins 2 and the interior of the outer surrounding tube wall 4.

Referring to Figure 9, a continuous clad aluminium strip 11 is fed from a reel 5 into the first station of multistation roll forming apparatus 6. Typically, the roll forming apparatus 6 has between 10 and 40 stations. each station typically comprising pairs of rolls arranged to symmetrically plastically deform respectiv portions of the aluminium strip to a predetermined pattern or configuration. For example, an initial series of roll stations will be arrange to successively deform the longitudinal peripheral portions of the strip to provide respective series of corrugated fins 2 shown in Figure 4 (only one peripheral portion is shown in Figures 4 and 5). Intermediate stations in the roll forming apparatus 6 successively deform the strip to the configurations shown in Figures 5 and 6 until, on leaving the roll forming apparatus 6, the configuration of the strip has been deformed to that shown in Figure 7 which is the finished configuration of the tube. Because the aluminium strip is arranged to be deformed to the required configuration symmetrically about its longitudinal axis 20, the manufacturing process using the series of "in-line" roll forming stations 6 is particularly convenient. It is therefore possible to conveniently form an efffectively continuous heat exchange tube from unitary sheet with integrally formed internal fins. Because the tube 1 is symmetrical about the brazed seam 3, the integrity and rigidity of the tube is also maximised.

On leaving the roll forming apparatus 6 the continuous tube is cut to the required length at a cutting station 7 before being carried on conveyor 8 to a heat exchanger jig 9 in which the cut to length tubes 1 are placed alternately with layers of concertinad fins 10 (which define the second fluid flow matrix) before the assembled heat exchanger is brazed in a single brazing operation.

Referring to Figure 8, certain stations in the roll forming apparatus may be provided with perforating means arranged to produce perforated louvres or slits 12 in the corrugated fins 2. The louvres 12 increase the turbulence of the fluid medium carried in the tube 1, and hence increases the heat transfer efficiency between the two fluid media.

Claims

1. A heat exchange tube comprising an outer wall and a plurality of internal fins extending longitudinally of the tube, the fins and outer wall being formed from a unitary portion of sheet or strip material, each of the fins comprising a respective corrugated portion of the sheet or strip material, characterised in that said fins comprise first and second series of fins, each series comprising a plurality of fins successively spaced in mutually opposed directions, from a common longitudinal seam line which opposed directions are transverse to the longitudinal direction of the tube, each of said fins being in the interior of the tube with alternating troughs and crests in thermally conductive contact with respective opposed

portions of an inner face of the outer wall.

2. A heat exchange tube according to claim 1, wherein the common longitudinal seam line comprises a bonded join.

3. A heat exchange tube according to claim 1 or claim 2, wherein in transverse cross-section the tube is substantially symmetrical about the seam line.

4. A heat exchange tube according to any preceding claim, wherein the shaped portions of the strip or sheet material defining each series of fins are separated from one another by interconnecting portions, which interconnecting portions are not provided with fins.

5. A heat exchange tube according to any preceding claim, wherein the series of fins are formed each adjacent a respective longitudinally running peripheral edge of the sheet or strip material.

6. A heat exchange tube according to any preceding claim, wherein the fins are provided with louvres or slits such that fluid may pass through the surfaces of the fins.

7. A heat exchange tube according to any preceding claim wherein the strip or sheet material comprises clad aluminium or clad aluminium alloy.

8. A method of forming a heat exchange tube comprising forming respective series of fins in respective deformable portions of strip or sheet material, and subsequently deforming further portions of the strip or sheet material to provide an outer wall surrounding the series of fins, whereby the series of fins extend from a common longitudinal seam line in mutually opposed directions which directions are transverse to the longitudinal direction of the seam line.

9. A method according to claim 8, wherein the strip or sheet material is deformed symmetrically about its longitudinal axis to form the heat exchange tube.

10. A method according to claim 8 or claim 9, wherein two respective series of fins are formed, each in the region of a respective longitudinally running peripheral edge of the strip or sheet material.

11. A method according to any of claims 8 to 10, wherein the deformable portions of the sheet material are provided with respective series of fins are folded toward one another causing intermediate portions of the sheet or strip material to wrap around the series of fins thereby providing the outer wall.

12. A method according to any of claims 8 to 12, wherein the tube is brazed along the seam line to form a joining interfac b tween the respectiv series of fins.

Patentansprüche

1. Wärmetauscherröhre umfassend eine Außenwand und eine Vielzahl von inneren Rippen, die sich in Längsrichtung der Röhre erstrekken, wobei die Rippen und die Außenwand aus einem einheitlichen Teil aus Blech- oder Bandmaterial geformt sind und jede Rippe einen entsprechenden gewellten Teil des Blech- oder Bandmaterials umfaßt, dadurch gekennzeichnet, daß die Rippen erste und zweite Reihen von Rippen umfassen, wobei jede Reihe eine Vielzahl von Rippen umfaßt, die von einer gemeinsamen Längsnahtlinie aus aufeinanderfolgend in einander entgegengesetzten Richtungen einen Abstand voneinander aufweisen, wobei die entgegengesetzten Richtungen quer zur Längsrichtung der Röhre verlaufen, und wobei alle Rippen im Inneren der Röhre mit abwechselnden Tälern und Gipfeln in thermisch leitendem Kontakt mit entsprechenden gegenüberliegenden Teilen einer Innenfläche der Außenwand sind.

2. Wärmetauscherröhre nach Anspruch 1, bei der die Längsnahtlinie eine befestigte Verbindung ist.

3. Wärmetauscherröhre, die im Querschnitt im wesentlichen symmetrisch zur Nahtlinie ist.

4. Wärmetauscherröhre nach einem der vorhergehenden Ansprüche, bei der die aus dem Band- oder Blechmaterial geformten Teile, die jeweils eine Reihe von Rippen definieren, voneinander durch Zwischenverbindungsteile getrennt sind, wobei die Zwischenverbindungsteile nicht mit Rippen versehen sind.

5. Wärmetauscherröhre nach einem der vorhergehenden Ansprüche, bei der die Rippenreihen jeweils benachbart zu einem entsprechenden, in Längsrichtung verlaufenden Umfangsrand des Blech- oder Bandmaterials geformt sind.

6. Wärmetauscherröhre nach einem der vorhergehenden Ansprüche, bei der die Rippen mit öffnungen oder Schlitzen versehen sind, so daß Flüssigkeit durch die Oberflächen der Rippen laufen kann.

7. Wärmetauscherröhre nach einem der vorhergehenden Ansprüche, bei der das Band- oder Blechmaterial plattiertes Aluminium oder eine plattierte Aluminiumlegierung umfaßt.

8. V rfahr n zur Herstellung einer Wärmetauscherröhre umfassend die Bildung jeweils von Reihen von Rippen in entspr chenden deformierbaren Teilen aus Band- oder Blechmaterial und die anschließende Deformierung weiterer Teile des Band- oder Blechmaterials, um eine Außenwand zu bilden, die die Rippenreihen umgibt, wobei die Rippenreihen sich von einer gemeinsamen Längsnahtlinie aus in einander entgegengesetzte Richtungen erstrekken, die quer zur Längsrichtung der Nahtlinie verlaufen.

9. Verfahren nach Anspruch 8, bei dem das Streifen- oder Blechmaterial symmetrisch um seine Längsachse deformiert wird, um die Wärmetauscherröhre zu bilden.

10. Verfahren nach Anspruch 8 oder 9, bei dem zwei Reihen von Rippen gebildet werden, jeweils eine im Bereich eines entsprechenden, in Längsrichtung verlaufenden Umfangsrandes des Band- oder Blechmaterials.

11. Verfahren nach einem der Ansprüche 8 bis 10, bei dem die deformierbaren Teile des Blechmaterials, die mit entsprechenden Rippenreihen versehen werden, aufeinander zu gefaltet werden, wodurch Zwischenteile des Blech- oder Bandmaterials um die Rippenreihen gewickelt werden und dadurch die Außenwand bilden.

12. V rfahren nach einem der Ansprüche 8 bis 11, bei dem die Röhre entlang der Nahtlinie verlötet ist, um eine verbundene Grenzfläche zwischen den jeweiligen Rippenreihen zu bilden.

Rev ndications

1. Tube d'échange de chaleur comprenant une paroi extérieure et une pluralité de nervures intérieures du tube s'étendant longitudinalement, les nervures et la paroi extérieure étant formées à partir d'une portion unitaire de matériau en feuille ou en bande, chacune des nervures comprenant une portion respective striée dudit matériau en feuille ou en bande, caractérisé en ce que lesdites nervures sont constituées d'une première et d'une seconde séries de nervures, chaque série comprenant une pluralité de nervures écartées successivement dans des directions opposées réciproquement, à partir d'une ligne de jonction commune longitudinale, ces directions opposées étant transversales par rapport à la direction longitudinale du tube, chacune desdites nervures se trouvant à l'intérieur du tube avec des creux et des crêtes alternés en contact thermiquement conducteur avec les parties opposées correspondantes de la face intérieure de la paroi extérieure.

2. Tube d'échange de chaleur selon la revendication 1, dans laquelle la ligne de jonction commun longitudinale comprend un joint collé.

3. Tube d'échange d chal ur selon la revendication 1 ou la revendication 2, dans lequel le tube, en section transversale, est sensiblement symétrique autour de la ligne de jonction.

4. Tube d'échange de chaleur selon l'une quelconque des revendications précédentes, dans lequel les parties formées de matériau en bande ou en feuilles définissant chaque série de nervures sont séparées l'une de l'autre par des parties de raccordement, ces parties de raccordement n'étant pas pourvues de nervures.

5. Tube d'échange de chaleur selon l'une quelconque des revendications précédentes, dans lequel les séries de nervures sont formées chacune pour être adjacentes à un bord périphérique correspondant du matériau en feuille ou en bande s'étendant longitudinalement.

6. Tube d'échange de chaleur selon l'une quelconque des revendications précédentes, dans lequel les nervures sont pourvues de volets à claire-voie ou de fentes, de telle façon que le fluide puisse traverser la surface des nervures.

7. Tube d'échange de chaleur selon l'une quelconque des revendications précédentes, dans lequel le matériau en bande ou en feuille comprend de l'aluminium en plaque ou un alliage d'aluminium en plaque.

8. Procédé de formation d'un tube d'échange de chaleur comprenant la formation des séries correspondantes de nervures dans des parties correspondantes déformables d'un matériau en bande ou en feuille, et, à la suite, la déformation des autres parties du matériau en bande ou en feuille pour créer une paroi extérieure entourant les séries de nervures, grâce à quoi les séries de nervures s'étendent depuis une ligne de jonction commune longitudinale dans des directions opposées réciproquement, ces directions étant transversales à la direction longitudinale de la ligne de jonction.

9. Procédé selon la revendication 8, dans lequel le matériau en bande ou en feuille est déformé symétriquement autour de son axe longitudinal pour former le tube d'échange de chaleur.

10. Procédé selon la revendication 8 ou la revendication 9, dans lequel deux séries correspondantes de nervures sont formées, chacune se trouvant dans la zone du bord périphérique correspondant, qui

s'ét nd longitudinalement, du matériau en bande ou en f uille.

11. Procédé selon l'une quelconque des revendications 8 à 10, dans lequel les parties déformables du matériau en feuille sont pourvues de séries correspondantes de nervures qui sont repliées vers d'autres parties intermédiaires du matériau en feuille ou en bande pour s'enrouler autour des séries de nervures, créant par ce moyen la paroi extérieure.

12. Procédé selon l'une quelconque des revendications 8 à 12, dans lequel le tube est brasé le long de la ligne de jonction pour former une interface de liaison entre les séries correspondantes de nervures.

Figure 1

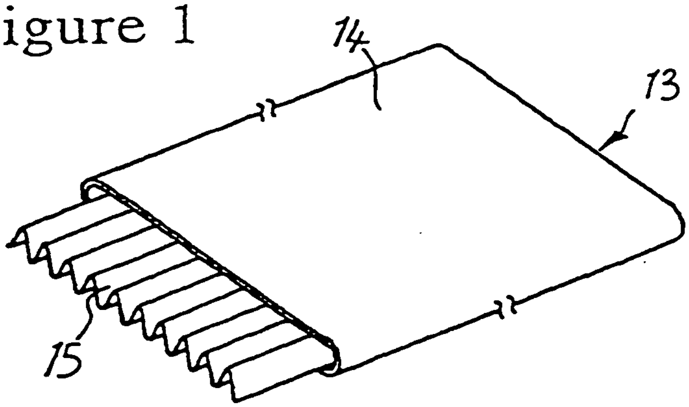


Figure 2

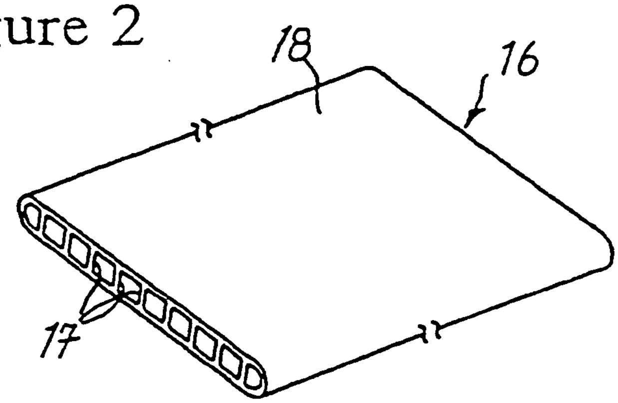


Figure 3

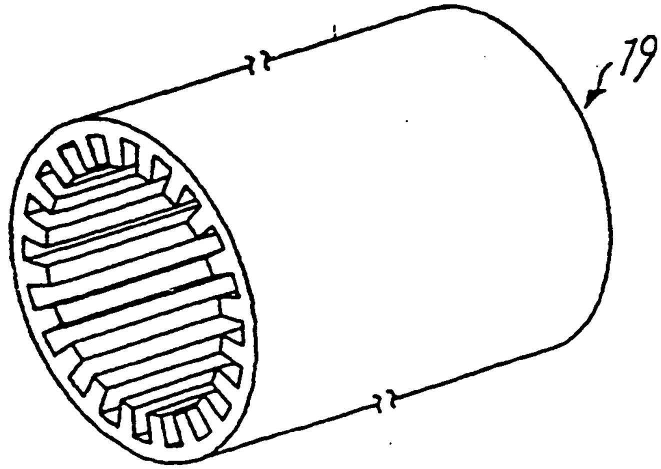


Figure 4

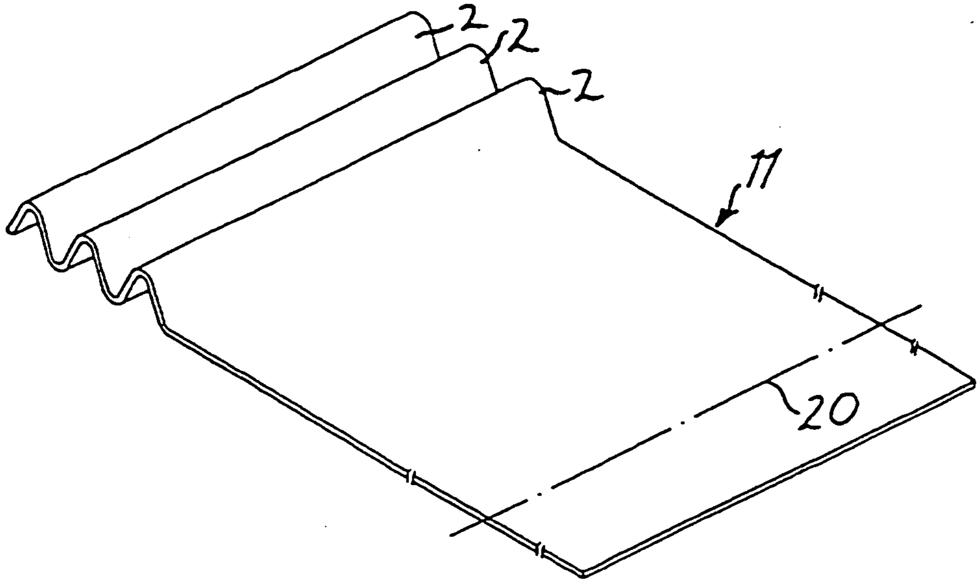


Figure 5

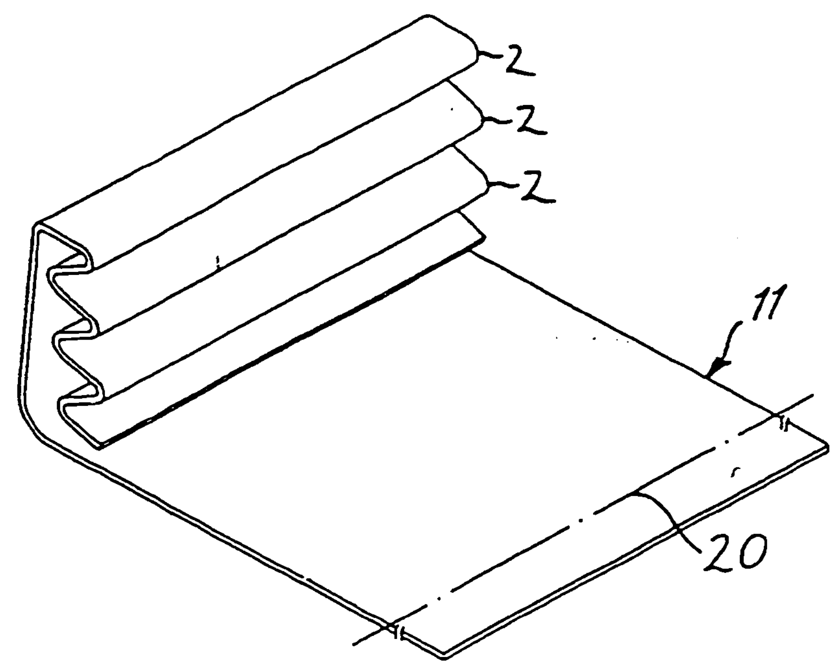


Figure 6

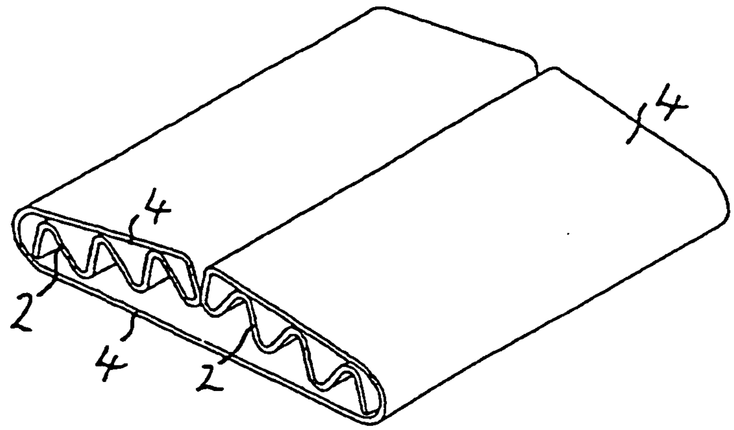
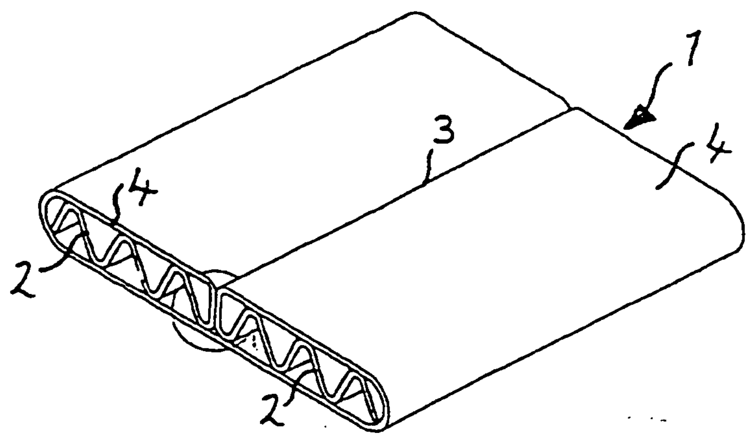


Figure 7



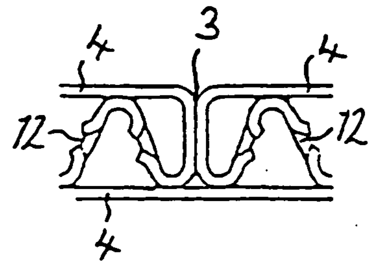


Figure 8

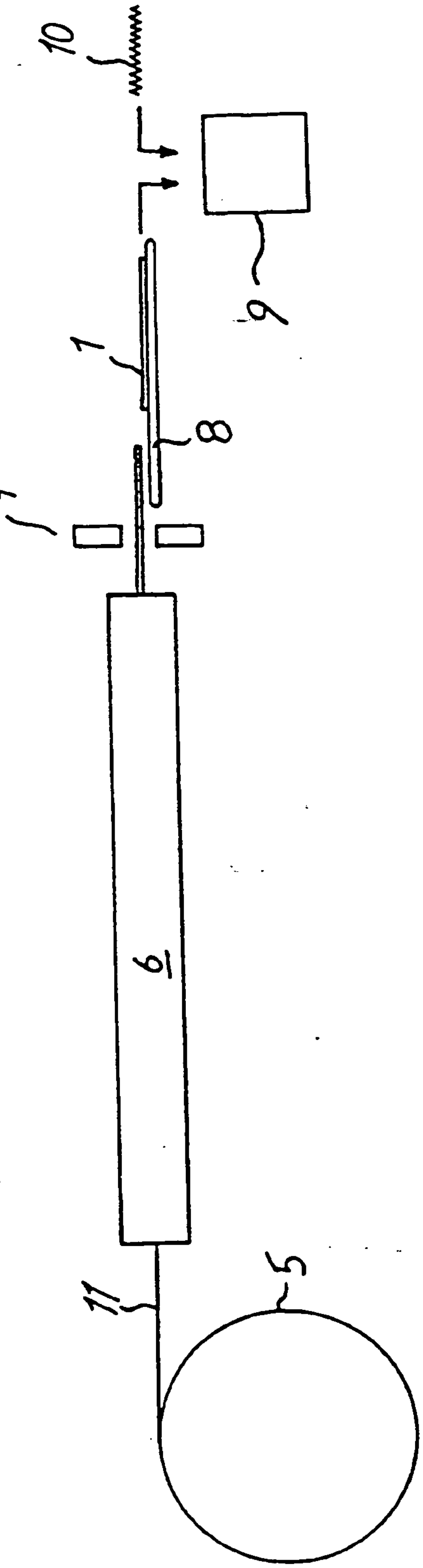


Figure 9